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ASCENT OF THE VOLCANO OF POPOCATEPETL.

BY A. S. PACKARD.

THIS famous volcano, called Popocatepetl from the Aztec *popoca*, smoking, and *tepetl*, mountain, was the objective point of my journey to the Mexican plateau. The Nevada de Toluca I had seen a few days previous from the town of Toluca, on the Mexican National Railway. This volcano, however, is not a simple conical peak, but its snow-covered dome rises 15,156 feet above the sea, and out of a mountain mass with four lesser elevations about it. From Toluca the crater is seen to be a very large one, and we were told that it is 1500 feet deep with a lake at the bottom said to be two and a half miles across.

Orizaba we were yet to see; but nothing could, we thought, exceed in interest the distant view of Popocatepetl from the top of our hotel in the City of Mexico, as the setting sun gilded its snowy dome, and as it went down painted its snow fields with roseate hues. It is the grandest mountain summit of the valley of Anahuac. It repeats, but with emphasis, the purity of form and massiveness of Mt. Shasta, in Northern California. Its twin sister, the volcano of Iztacihuatl, or the "snowy woman," forms a part of the same isolated range—the Cordillera of Ahualco—and was doubtless thrown up at the same time; but it has no central dome cleaving the sky, the mountain mass extending as a range running nearly north and south, with three broken irregular snow-covered summits, of which the central is the highest, reaching an altitude of 4786 meters or 15,705 feet above the sea. The height of Popocatepetl has been variously estimated. Humboldt placed it at 5400 meters, or 17,716 feet; Guyot gives its altitude as 17,784 feet; Humboldt's measurement combined with those of two later observers, is 17,853 feet, while the French savans of the Maximilian expedition put it as high as 18,362 feet. The height of the City of Mexico above the sea is 7482 feet, so that we had before us an ascent of a little over 10,000 feet. This is nearly 2000 feet less of an ascent than that of Mt. Shasta, which is 14,442 feet high, while the plain out of which the California volcano rises is about 2000 feet above the sea.

For two days previous to starting we were occupied in arranging for the ascent. Our party consisted of three. Mr. F. A. Ober, author of the interesting *Travels in Mexico*, who had pre-

vously made the ascent, kindly accompanied us to the snow line as guide, interpreter and friend.¹ We laid in supplies of boiled chicken, other meats, bread and tea for our night at the ranch and the noon lunch on the summit. By the kindness of Messrs. D. S. Spaulding & Co., I obtained a letter from General Gaspar Sanchez Ochoa, the proprietor of the mountain, to one of his employés, Sr. D. Mariano Mendizabal, at Amecameca, who was ordered to send his son Rafael to guide us to the summit. The day previous to leaving the City of Mexico I telegraphed to Senior Norriega, a grocer at Amecameca, for horses and guides for a party of four. That evening the sun sat clear on Popocatepetl, and the weather promised to be clear and fine on the morrow.

On the morning of March 19th, after an early breakfast, we drove to the railroad station at San Lazaro, leaving it at 8 A. M. The sky was a little overcast, but soon the sun came out clear and hot. We soon crossed the edge of Lake Tescuco over a causeway, along the canals traversed by Indian dugouts, over the shallow reedy lake, in which were men and boys naked or stripped to the knees, wading through the water, fishing in its shallow depths with nets for shiners or axolotls. The track then leaves the lake and its flaggy, reedy shores and passes over a broad dry plain, the ancient bottom of Tescuco, the western portions of which are said, by Humboldt, to have been covered with water in 1521. Here were to be seen the mounds of that busy ant, *Pogonomyrmex occidentalis*, so familiar a sight from Montana to New Mexico and from Kansas to Reno, Nevada.

At the first station of Equipajes we get a fine view of Popocatepetl and Iztacihuatl. The railroad then skirts the borders of Lake Chalco, and we see upon our right many of the famous floating islands covered with green flags and reeds, which had survived since the time of Cortez. At the station of Ayotla the Indians crowd about the train offering fishes wrapped in the leaves of the pond lily, and here we bought half a dozen large axolotls for a cent apiece. We then passed within sight of Chalco, the oldest Indian town of the valley of Anahuac. Amecameca, the town where we take our guides and horses, is about forty miles by rail from Mexico and 1274 toises or 8223 feet above the sea. It is the highest town in Mexico; its elevation renders

¹ The two others were Professor J. W. P. Jenks, of Brown University, and Hon. Titus Sheard.

it more salubrious and cooler than Mexico, being nearly 600 feet higher than that city, and it is somewhat frequented by invalids from the city in hot weather. Before reaching the town, however, we pass through foothills covered with a growth of pines and oaks, with an intermixture of maguey or century plants under cultivation. The scenery now becomes very grand as we skirt along the ranges—from four to six—which are parallel with Iztacihuatl. At 10 A. M. both volcanic peaks were enveloped in cumulus clouds, but they rolled away from the mountain of the “white woman,” still, however, obscuring the snow-clad dome of Popocatepetl. The massive base of Iztacihuatl below the clouds was seen to be studded with conical peaks, any one of which would be a prize in Maine or New Hampshire. As the train stops at Amecameca we pass the hill of Sacramonte, covered with a dense growth of noble cedars and pines surrounding the chapel on the summit, and enter the railroad hotel at eleven o'clock for dinner, first, however, regaling ourselves with the full and superb view of Popocatepetl and its sister volcano, whose serene heights now clear and well-nigh cloudless, looked down upon the town spread out over the valley at their feet.

After dinner we met our guide Rafael with his men, horses and pack mules at the grocery store of Señor Francisco Norriega, where we laid in additional provisions, and punctually at one o'clock started for our camp at the base of the peak. Our party consisted in all of seven horsemen, with two pack mules and three *mozos* or *guias* on foot. A *guia* is an assistant guide, usually an Indian servant or *mozo*. For the benefit of any one intending to make the ascent, I give in a foot-note¹ the particulars of our outfit of guides, servants, etc., with the prices, being a copy of the items in Rafael's bill.

14 horses at \$2.00 a day.....	\$16 00
3 guias at \$2.00.....	12 00
2 mules at \$1.50.....	6 00
1 barley for the horses and mules.....	1 75
6 pieces of leather for making sandals.....	1 31
8 straw mats.....	1 50
8 leather thongs.....	50
8 yards of cloth for wrapping the feet.....	1 75
Thread, etc.....	25
A mozo to look after the horses at \$3.00 a day.....	6 00
Rafael Mendizabal.....	10 00

\$57 06

We were urged to discard our shoes and let the guias wrap our stockinged feet in rags with a pair of rough leather sandals, but we preferred to wear over woolen stockings our ordinary high shoes and over the latter a pair of arctics, and found that they answered the purpose admirably in walking over the soft snow and yielding sand of the peak, while our feet did not suffer from the piercing cold winds of the early morning hours. We had provided ourselves at Mexico with a pair of native blankets for the bivouac at the ranch. Thick gloves are also needed, while blue-glass goggles, which most of the party bought at Norriega's, are absolutely indispensable. It is impossible to walk over the snow fields of Popocatepetl in the glaring sunshine without them. I carried and tried to use a pair of colored eyeglasses, but they would slip off while walking, and proved a source of constant annoyance until my *guia* changed with me, and considerably made the best use he could of my glasses.

The charges of the guide Rafael were fair, but we could have dispensed with the Spanish assistant guide and the mozo to attend the horses. The *guias*, or sub-guides, were Indians, nearly or quite full-blooded, and were strong, faithful young men. They expected and received besides their regular pay a gratuity for their services. Were I to make the ascent again alone, a good *mozo* besides the guide would be indispensable. No one should attempt to ascend the mountain alone without such attendance, as some accident might happen on account of the altitude, though there is no dangerous climbing. We were gone a day and a half from Amecameca, but of course two working days were spent and charged in our bill.

Our cavalcade passed through the dusty hot streets of the town, here and there shaded by hedges of cactus or maguey and rows of mesquite trees, the unclouded tropical sun beating upon our heads, though a cool westerly breeze somewhat refreshed us. Leaving the town the road passed through broad wheat and corn fields, and in an hour's ride from the city we left the plain and came to the edge of the foothills of the cordillera of Ahualco, the range from which rises the two volcanoes, of which Popocatepetl is the southernmost.

We were now ascending, and were for several hours to ascend the range, into the pass between the two volcanoes over the trail made by Cortez during his march from Puebla to the City of

Mexico. We met trains of pack mules and donkeys coming from Puebla, and it added no little zest to our ride to recall the memorable march of the Spanish conquistador from the plains of Puebla to the then famous Aztec capital of Tenochtitlan.

In his *Essai politique sur le Royaume de la Nouvelle-Espagne*, Humboldt refers to this road or trail, which was first opened by the ancient Aztec couriers from Mexico to Puebla by way of Amecameca.¹

The plains over which we trotted were evidently an old lake bottom. The road now ascended between low rounded hills which had every appearance of moraines; they were composed of loose sand and gravel, with boulders of black basalt like that forming the volcano, and sloped gradually down to the plain. One very regular mound which we passed on our right, which rose abruptly from a corn or wheat field, seemed to have been artificial in its origin. It is Tetepetongo, "the hill of the round stones," and according to tradition, says Ober, was formerly used as a place of sacrifice. But the zone of moraine-like hills we were now passing over contrasted strikingly with the broad flat plains beneath us and with the ragged volcanic foothills of Iztacihuatl far above us on our left. Though this peak was capped with clouds, the larger part of the snowy dome of Popocatepetl was in full view, and from it two glacier-like streaks of snow led down the valleys, losing themselves in the ragged lava streams at the base of the cone. As we pass onward and upward conical tumuli of loose débris from the mountains above confront us, and well-marked lateral moraines extend out upon the plain on each side of the trail. We should judge that the level at which we saw the lowest moraines was about 9000 feet above the sea; from that level they were observed up to or near the snow line, the height of which above the sea, in the latitude of the City of Mexico, Humboldt puts at 4600 meters or 15,333 feet. We were unable to see such good clear natural sections of a

¹ Lorsqu'au mois d'octobre de le l'année 1519, le corps d'armée des Espagnols et des Tlascalteques marchoit de Cholula à Tenochtitlan, il traversa la Cordillère d'Ahualco, qui réunit la Sierra Nevada ou Iztacihuatl à la cime volcanique du Popocatepetl. Les Espagnols suivirent à peu près le même chemin que prend le courier de Mexico pour aller à la Puebla par Mecameca, et qui se trouve tracé sur la carte de la vallée de Tenochtitlan. L'armée souffrit à la fois au froid et de l'extrême impiété des vents qui règnent constamment sur ce plateau.—*Essai politique, etc.*, II, 672.

moraine as would have been desirable, but in one instance the moraine was composed of the fine mud scrapings of the lava with rounded boulders of basalt of all sizes up to four or five feet in diameter, the hill being covered with wheat and small corn. Moreover the hills above the moraines on each side of the valley had apparently been molded by ice. I infer from all I saw on the ascent that the ice must have filled the valley or pass between Iztacihuatl and Popocatepetl, spreading out over the plateau like a *mer-de-glace* and sending glaciers down to the lakes then covering the plains of Anahuac. Above the rounded hills were rough volcanic spurs and hills which may once have overlooked the ice streams.

It would appear, then, that the Quaternary lakes of the Mexican plateau (unmistakable evidences of which I saw throughout the country from Laredo to San Luis Potosi, and thence to the City of Mexico, as well as along the Mexican central route to New Mexico) were fed by the melting of glacial ice in the high sierras. At any rate in the valley of Anahuac the volcanoes rising above it must have been covered with glaciers which descended to a point 9000 feet above the sea, and about 1000 feet above the present level of the plains.¹

The change in vegetation as we left the plains and wound among the moraines was an interesting feature of the ride. The zone of cactus, nopal, mesquite, etc., of the Mexican plateau was replaced by a belt of pines, aromatic firs and cedars; the flowers had changed in character and become more numerous and varied than on the dry and dusty plains; lupines predominated, relieved by a showy red labiate flower and yellow-flowered shrubs. Of

¹ In conversation with Mr. Otto Finck, to whom I described the moraines about Popocatepetl, he told me that what he regarded as true glacial moraines extended down along the route of the Mexican railway as far as Peñuella, which is three miles east of Cordova, and is 2500 feet above the sea, Cordova being 2700 feet elevation. I had seen boulders of porphyry above the city of Orizaba, and Mr. Finck, who is an observer of long experience in the State of Vera Cruz, having explored the country for hundreds of miles on foot, and being a naturalist of experience, kindly took me down to the bed of the river, where were boulders of different kinds of porphyry, evidently derived from the plateau above and westward. On the plains of Jaumatlan and Chocaman, he told me, are boulders of porphyry, weighing 200 tons, and also glacial scratches. Mr. Finck drew for me a section of what he regarded as a moraine observed at the Pass of Metlac, in which were angular blocks of porphyry of ten or twelve kinds, with gneiss, which must have been transported from the plateau above. Below an elevation of 2500 feet Mr. Finck had not in the State of Vera Cruz, or elsewhere in Mexico, observed any glacial marks.

deciduous trees, willows abounded, but few if any oaks. Through these forests, not very dense or continuous, pumas and wolves were said to roam. The insect life of the plains is scanty in the dry season, but in this zone bees and butterflies of different species visited the flowers. The zone of pines and willows was succeeded by a belt of tall coniferous trees like a spruce with a fir-like habit; their slender shafts two to three feet in diameter (in one case of a tree felled with the ax, five feet) pierced the clear sky over perhaps 125 feet. This noble tree had very broad leaves and a deep red bark, like the red woods around the base of Mt. Shasta. This zone of red wood was succeeded by a belt of low short-leaved pines which grew shorter and more stunted until at half-past four we came to banks of snow lying on the summit of the grassy pass, the remnants of larger fields which had but lately disappeared. The air was now cool and even chilly, the ground was damp and often wet; here it was early spring, like our first of April in New England, too early for flowers; scattered plants, perhaps Alpine but quite unlike any we have seen in the Rocky mountains, were not yet in flower, and to add to the resemblance to a northern spring a flock of veritable robins flew among the pines; they were lingering on the flanks of Popocatepetl before taking their final flight northward.

The path to the ranch now left the Puebla trail and led us among the pines to the sheds where we were to spend the night. The rancho was reached at 5.40, and an hour still remaining before dark, I walked to a ravine over piles of volcanic ash and lapilli to entomologize under fallen pine logs and the bark of stumps, finding lizards, beetles, spiders and myriopods quite unlike any forms yet seen in the *tierra templada* below, but with no trace of Alpine characters.

The ranch was a deserted shed and furnace-house for roasting the crude sulphur formerly collected by the *volcaneros* or peons at the bottom of the crater.

Darkness gathered early about the ranch, but in the bright moonlight the massive, marble-like dome of Popocatepetl rose directly above us. Our horses and mules were left to stand in the open air while we bivouacked in the shed, in the center of which was a raised circular fireplace on which our guias made a fire of sticks and logs, the smoke and sparks passing up through a hole left in the middle of the roof. The Indians boiled their

coffee in their glazed earthen jars, which in the long run withstand the heat of the fire better than a tin coffee-pot; they made tea for the party in other vessels of domestic manufacture; they refreshed themselves on cold tortillas and chili, the twin components of a Mexican meal, and then cut out their sandals for the morning's climb, while we dismembered a cold broiled fowl of pronounced toughness and ate it with excellent native bread and tea. To the tourists and head-guides was assigned a sort of low raised divan or floor covered with hay, over which we spread the straw *petates* or pallets, and finally a blanket, with a second blanket and a coat over us. The *guias* and muleteer lay on the mud floor, their feet to the fire; their swarthy faces and limbs not visible in the gloom, their white cotton garments concealed by their high-colored serapes or blankets. They slept soundly through the night, but not the tourists; the beds were uneven, an occasional flea danced a jig on our hands and faces, a rain and hail storm with a strong gale of wind rattled about the ranch; towards morning it grew very cold and chilly; added to this two of our number, owing probably to the altitude, were unfortunately seized with vomiting and diarrhoea, so that there was little or no sleep for the Americanos that night.

At 3.40 A. M. of the 20th I awoke the party, the *guias* replenished the fire, prepared the coffee and tea, saddled the uneasy horses now shivering in the cold frosty morning air, and at 5.30 we had mounted our steeds and were under way for the peak. It was a bright, crisp, clear, cold morning, the stars still shining brightly, while a piercing cold wind swept down the valley over the pass. Our guides had wrapped their legs in thick layers of cotton rags, wound their *serapes* tightly about them, and we found that our overcoats and gloves were but a slight protection against the intense cold. For two hours we slowly crept up by a zigzag trail, urging on our unwilling nags over the slope of the mountain; first passing through the pine woods, then descending a barranca or ravine, through which ran a stream fed by the snows of the peak. The trail then wound along the base of the cone over fields of loose, deep, coarse, black, volcanic sand, through which rose scattered jagged masses of black lava. Our faltering horses and not over enthusiastic guides toiled upward and onward, until at 7.30 we reached La Cruz, a rock on which was a wooden cross, where we were to leave our horses

and begin the ascent on foot. Here, owing to sickness induced by the altitude, my companions were obliged to return to the ranch. Taking Rafael and two *guias* I went on.

The ascent of Popocatepetl is prosaic in the extreme. Much to my surprise there were no rocks to clamber over, no difficult climbing, but an interminable steeply inclined desert of deep, coarse, yielding, volcanic sand, covered with a thin sheet of snow—névé—making it exceedingly hard walking, to say nothing of the effect of the great altitude upon the heart. The height of the lower level of the snow-line Humboldt estimated at 15,300 feet.

The cone of Popocatepetl is like that of Vesuvius—only more so. We roughly estimated the angle of the slope at 30° , but judging by our feelings after two or three hours' climb, it seemed like 75° .

There is no definite trail up the mountain, and at no point on the route can the summit or mouth of the crater be seen, so that there is no goal in sight to draw one's attention away from the labor and fatigue of the ascent. Looking up hopelessly from time to time as we stop to get breath, anxiously trusting to obtain a glimpse of a rocky peak breaking through the crust, nothing meets the eye but a vast snowy slope melting away far aloft in the sky, the unsullied surface like polished marble of more than parian purity, fading gradually away to be replaced by the deep, fathomless azure of a Mexican sky.

By eight o'clock the sun had gained more power, the exercise warmed us, so that we no longer suffered with the cold, but the effect of the intense sunlight upon the eyes was blinding and painful; it would have been well-nigh impossible to have made the ascent without blue goggles.

Our small procession moved in the following order: my own particular *guia*, a young, stout, willing Indian picked out a way over the rough snow or sand, as the case might be, the writer followed, planting his feet in the prints made by the Indian, and supporting himself with a rude, improvised alpenstock, usually held in both hands; behind followed the supernumerary *guia*, carrying the lunch basket on his back, while Rafael brought up the rear, with the air of one fulfilling a contract rather than enjoying the ascent. And it was hard work. I have ascended Pike's peak three times, walked up Gray's peak twice, have climbed the crater of Mt. Shasta, which is over 12,000 feet high, ascended

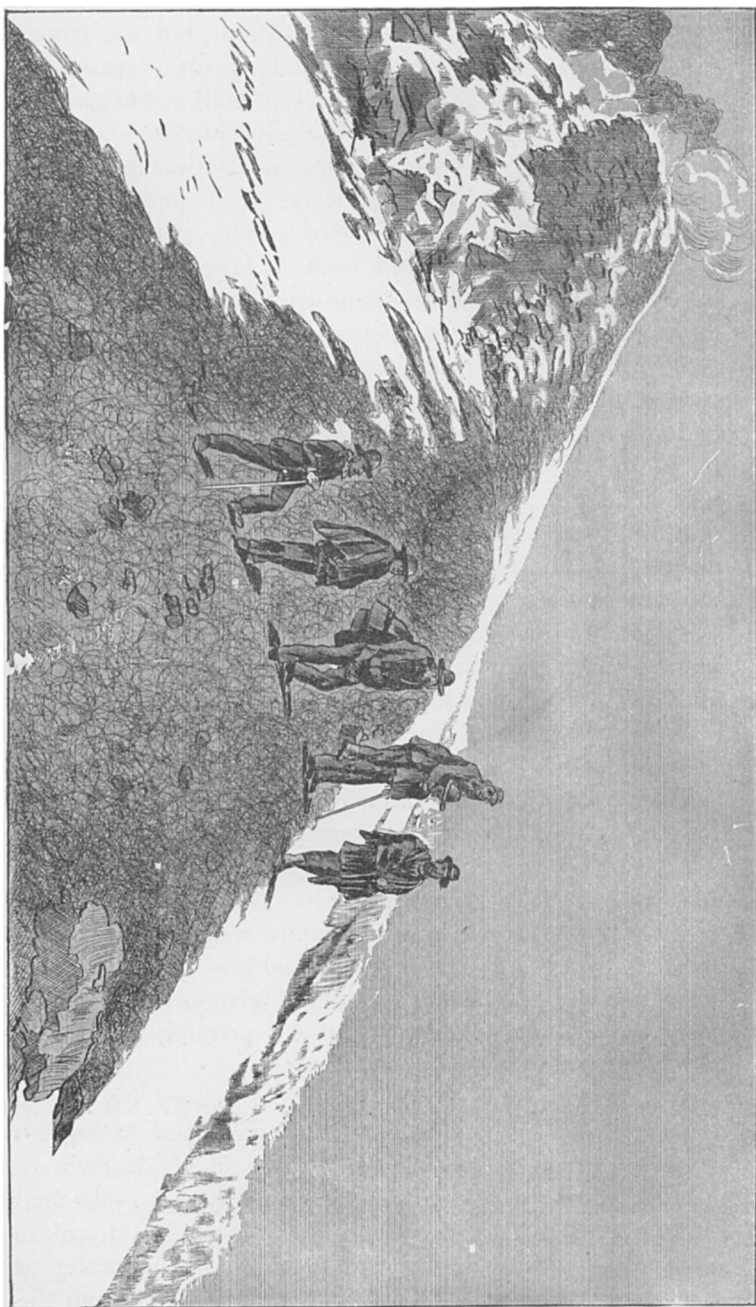
Vesuvius and Snowdon, and not a few peaks in the White mountains, the Adirondacks and Northern Maine, but the labor of the ascent of Popocatepetl, owing to the far greater altitude and the consequent rarity of the atmosphere, as well as the yielding sand and the nature of the snow is peculiarly difficult.

To my surprise the snow lay on Popocatepetl as a thin sheet of from a foot or two to six or eight feet thick—deeper of course in the ravines, but the ravines were of a mild type. The ascent is made from the northerly and westerly side; the deepest ravine was filled with snow passing beneath into ice, thus forming an incipient glacier perhaps nearly a mile in length. Looking at it the day previous, from the road below, I supposed it to be a true glacier filling the ravine, but it can scarcely be regarded as such, whatever may have been its dimensions in early times.

The surface of the snow fields over which we walked was exceeding rough. The snow was, on the average, about three feet deep, cut up by deep narrow fissures lying at various angles to our line of march; the footing was thus very rough and uncertain; the snow grew softer as the sun rose higher, and it was impossible at times to prevent slipping and falling down. Four hours of such work to one not hardened to mountain climbing at such an altitude, reaching nearly or quite 18,000 feet, are no child's play. One advances three or four steps, and thoroughly exhausted sinks down upon his staff to rest and recover his breath; his heart beats in a wild extravagant fashion, and his breathing is short, quick and labored. No one should attempt the ascent who has not a healthy heart and sound lungs, and is not under fifty. There is danger of over-fatigue.

At about half-past ten the summit seeming no nearer than at the start from La Cruz, I asked Rafael how long it would take to reach the top. He, thinking I might give it up, craftily replied, "*dos horas*;" not satisfied with this I privately asked my trusty guide in front, and he said, "*una hora*."

Just then a whiff of sulphur vapor passed by, the draught though nauseous was inspiring, and gave new strength to my tired limbs, and at eleven o'clock I suddenly walked over the edge of the crater and could look part way down into the bowels of Popocatepetl. We were on the summit, could walk on level ground along the narrow sandy edge of the crater, without fatigue, the heart at once resumed its normal beat and the respiration became again natural.



Summit of Popocatepetl, just within the north-west edge of the crater.

The transition was thrilling. Here we were on the summit of the highest mountain between Mt. St. Elias in Alaska, and Chimborazo in Peru! The sky was well-nigh cloudless, a few cottony masses hung over Iztacihuatl to the north of us, partly obscuring its peaks; the plains of Anahuac and the Puebla valley bathed in the sunlight, and wrapped in a warm, soft haze, stretched for hundreds of miles away west and east; the volcano of Malinche to the north-east seemed like a pigmy cone; the city of Puebla could be distinguished, but Cholula and its pyramid, which lay nearer, were lost in the haze; we could not detect the city of Mexico and its adjoining lakes, nor could I make out the volcano of Orizaba, which lay to the eastward 150 miles.

But our interest centered in the crater. In comparison with that of Vesuvius or Mt. Shasta it was, it must be confessed, tame. Many have looked down into the crater of Vesuvius; that of Mt. Shasta is a funnel-shaped chasm over a thousand feet in depth, the snow fields extending from the rim to the bottom, in which lies a frozen lake. The view into it was memorable.

Descending a few feet to a rock overhanging the chasm now before us, we could take in the entire basin. It seemed to us to be about 500 feet deep and from 1000 to 1500 feet across at the mouth, but according to Gen. Ochoa's measurements it is a thousand feet deep, and the floor is 200 meters in circumference. It is not an irregular chasm like that of Vesuvius, but like a vast cauldron in shape, the steep sides visible all around, and the bottom broad and somewhat flat, with no large, deep fissures visible. Gen. Ochoa told Mr. Ober that there are more than sixty solfataras or smoking vents in the crater, one of them over fifty feet in circumference; he called the vents *respiradores*.

The northerly rim is of loose volcanic sand which has been blown up out of the crater. Perhaps two-thirds of the rim was of solid lava more or less jagged and irregular, the highest portion on the south-east side. Looking across from the northerly side one is confronted by three well-marked layers of vertically columnar basalt marking three successive overflows, while a less regular fourth layer indicated an additional eruption. The rock composing the sides of the crater, the mountain itself and the sand lying on its flanks is a tough, black basalt, slightly porphyritic.

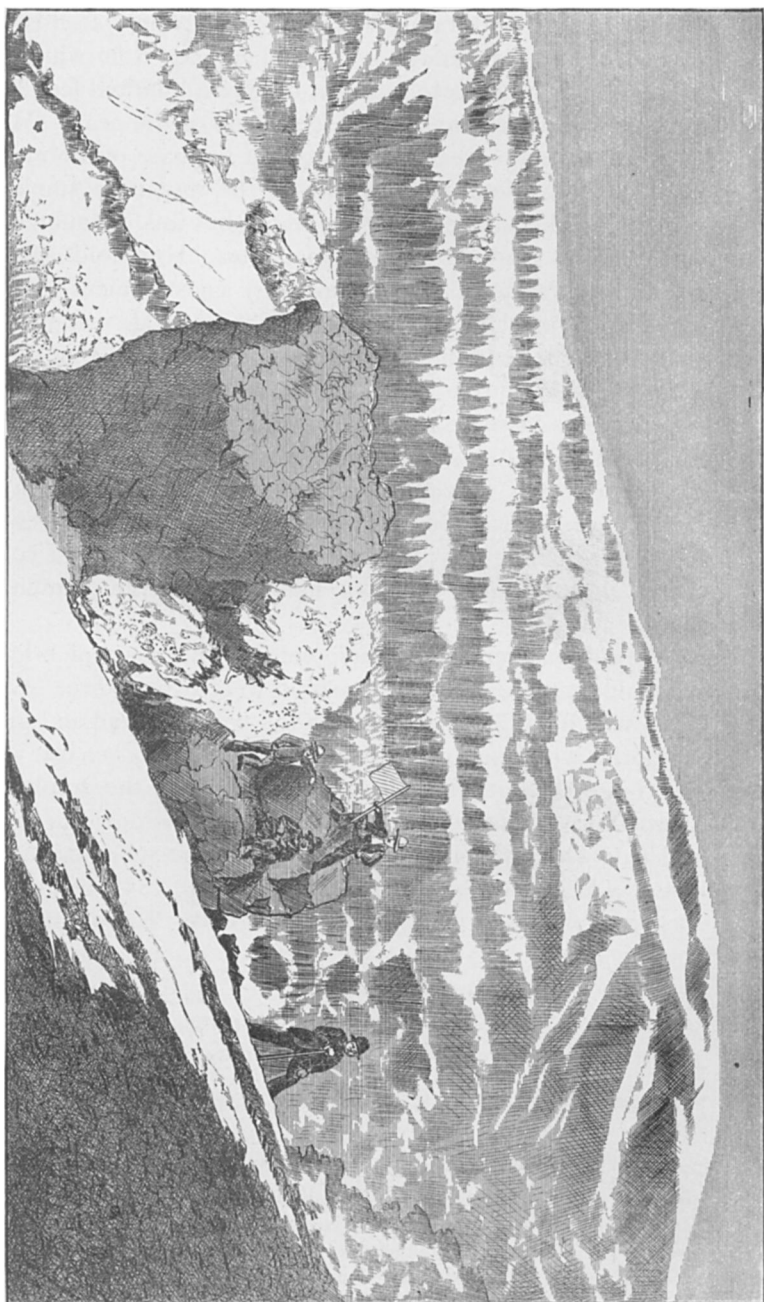
Near the rim of the crater on the west side is a sulphur fuma-

role or *respirador*, a fissure from which issued clouds of sulphur fumes. At the bottom of the crater were plainly seen two large sulphur vents or *solíataras*, with smaller ones from which clouds of vapor rose perhaps to a height of over a hundred feet, but certainly not half way up to the edge or top of the peak. Whether these fumes can be seen from below, at the base of the mountain, is a question. Some still claim that the mountain smokes, and that the smoke can be seen from below, but this is doubted. The assertion was made in the time of Cortez. Humboldt says: "Ce volcan, que j'ai mesuré le premier, est constamment enflammé; mais depuis plusieurs siècles on ne voit sortir de son cratère que de la fumée et des cendres."¹ It is not impossible that the slight amount of sulphurous vapor which is emitted from the crater may at times increase and be visible at night by moonlight from the plains below, or even in the daytime during certain states of the atmosphere. I well remember that in May, 1872, a month after the great eruption of Vesuvius, no smoke was seen to rise from the crater by day, but by moonlight, at Naples, I could detect a slight column of vapor hanging over the summit of the cone.

The sulphur vents were surrounded with masses of bright yellow sulphur. Near where we stood were two or three stumps of posts which had been driven into the volcanic sand and gravel to support a windlass or winch, by which the *volcaneros* were let down into the bottom of the crater to gather the sulphur there. It was borne in sacks on the backs of Indians down to the ranch or sheds where we spent the night, and there sublimed in earthen pots. The crater was not measured until 1856, when General Ochoa estimated its depth and circumference. We roughly guessed that its depth was about 500 feet, but distances, looking down into a mountain, are very deceptive. It appears that in the time of Cortez a Spaniard descended the crater, tied to a rope, to the depth of from seventy to eighty fathoms or 420 to 480 feet.²

¹ Essai politique sur le Royaume de la Nouvelle-Espagne, Tom. II, p. 238.

² "Ou voit, par la troisième et la quatrième lettres de Cortez à l'empereur, que ce général après la prise de Mexico, fit faire d'autres tentatives pour reconnoître la cime du volcan, qui paroissoit fixer d'autant plus son attention, que les indigènes lui assuroient qu'il *n'étoit permis aucune mortel de s'approcher de ce site des mauvais esprits*. Après deux essais infructueux, les Espagnols réussirent enfin, l'année 1522, à voir le cratère du Popocatepetl; il leur parut avoir trois quarts de lieue de circonférence, et ils trouvèrent sur les bords du précipice un peu de soufre qui avoit été



Within the edge of the crater, looking across to the lava beds on S. E. side, forming the highest point of the summit.

An hour was spent on the inside of the edge of the crater, where we ate our lunch. The air was delightfully clear and cool. We were wonderfully fortunate in having so clear and bright a day, as the peak is usually covered with clouds by ten o'clock, and for this reason we were advised to start from the ranch by daybreak. The summit is of small extent, the edge of the crater is quite free from snow, but a few feet down on the outside from the edge on the north side, the snow begins as a perpendicular wall, three or four feet deep, like a petrified crest of a wave, as if the snow had been melted by the breath of the crater. The following week on visiting Puebla, which lies due east of the mountain, we observed that there was no snow on the eastern and southern sides of the volcano, the snow fields on the northern side being preserved from melting by their more shaded situation. Without doubt the snow fields of Iztacihuatl, which extend along the western side of the range, are also thin, and give rise to no extensive glaciers.

Whether there has been an eruption of Popocatepetl in historic times is a matter of doubt. It is possible that showers of ashes may have been blown out of the crater, but certainly there is no recent stream of lava or obsidian on the mountain slopes. Humboldt, however, quotes from a letter of Cortez stating that much smoke rose from the crater, and that clouds of ashes enveloped two men who ascended part way up the mountain.¹ From this it would seem that the volcano was rather more active three and a half centuries ago than at present, but it is to be doubted whether there has been an actual eruption of lava within a thousand years. According to various authors there were eruptions in 1519, 1539 and 1540.

déposé par les vapeurs. En parlant de l'étain de Tasco dont on se servit pour fonder les premiers canons, Cortez rapporte, 'qu'il ne manque point de soufre pour fabriquer de la poudre, parce qu'un Espagnol en a tiré d'une montagne, de laquelle sort perpétuellement de la fumée, en descendant, lié à une corde, à la profondeur de 70 à 80 brasses.' Il ajoute que cette manière de se procurer du soufre est très dangereuse, et que par cette raison il sera plus prudent de la faire venir de Serville" (*Essai politique*, etc., II, 673). The depth of eighty brasses or fathoms would be 480 feet.

¹ However Cortez expressly says, "That their men ascended very high, that they saw much smoke go out, but that none of them could reach the summit of the volcano, because of the enormous quantity of snow which covered it, the intensity of the cold and the clouds of cinders which enveloped the travelers" (*Essai politique*, etc., II, 672).

Here in passing I may remark that Orizaba is now said to be slightly higher than Popocatepetl, though Humboldt claimed that the latter was 600 meters higher than any other mountain from Mt. St. Elias to the Isthmus of Panama. Mr. A. H. Keene, in the *Encyclopedia Britannica*, gives the height as 17,176 feet. I obtained excellent views of this noble volcano at different points along the Mexican railway to Cordova. Seen from the west the snow fields stretched in glacier-like streaks down its slopes; at the station of Esperanza, however, the clouds parted so that the summit could be seen from the south, and it was observed that the dark streaks of sand or rock extended in broken patches to the very summit. Orizaba rather disappointed me from this point; it is far less imposing and majestic a peak than Popocatepetl; it is not so isolated, its great height being apparently lessened by the high mountains of the Sierra Nigra extending from it towards the railroad. Moreover its summit is broken up into subordinate peaks. Farther on near where the railroad descends into the great *barranca* or ravine west of the town of Orizaba, the volcano of that name is seen to be of solid lava, furrowed by deep ravines; while Popocatepetl is more like a vast conical heap of ashes. Never, however, shall I forget the magnificent view of Orizaba which I had from under the coffee trees and bananas of Cordova. It was eleven o'clock in the morning, the clouds had lifted and rolled away from the mountain, which rose in a magnificent conical mass far above its humbler fellows of the Sierra Nigra. From the illustrations given by Humboldt I imagine that the finest view of this imposing peak is from the forest of Xalapa, to the north-east. This volcano is said to have been quiet since 1566.¹

¹ Mr. Hugo Finck of Cordova, who has explored the base of Orizaba, told me that the crater is one and a-half miles long and a half mile wide, but that it cannot be entered. He saw Orizaba smoking, probably the gases from the solfataras, and stated that the mountain had erupted near the base, where there are small craters. He has seen a glacier near the summit, and thinks there are others; they slide down and melt away, the summit above being bare, with no *mer-de-glace*.

It seems probable that there are at the base of Orizaba Archæan rocks, as Mr. Finck told me that gneiss occurs as far up the sides of the mountain as 13,000–14,000 feet, while higher up the mountain is composed of a grayish porphyry. In the center of the Sierra Nigra and the mountains southward between Esperanza and Orizaba, are Silurian, Devonian, and Carboniferous strata with a fetid black limestone, succeeded by bluish Jurassic limestones containing fossil fishes, oysters, belemnites and ferns. In the Cretaceous hills three miles east of Cordova fine ammonites occur. It seems probable from what Mr. Finck told me, and my own hasty observations from Mexico to Cordova, that all these principal formations occur from the center of the Mexican plateau to the seacoast at Vera Cruz, the plains of the latter State being of Tertiary and Quaternary age.

But we must reach Amecameca by dark, as in traveling through the woods after twilight we might fall in with objectionable company.

At twelve o'clock we began the descent, and it reminded me strongly of the twenty minutes' descent or run down Vesuvius. After zigzagging down over the snow and ice, now quite yielding, stopping frequently to rest one's tired knee-joints, on reaching the sand below the snow fields, my two *guias* each took one of my arms and we ran down the long sandy slope arm-in-arm. We reached La Cruz by about two o'clock, and walking on a mile or so more down the slope, I found a horse which Mr. Ober had sent me, in waiting. Reaching the ranch at about three, after half an hour's rest and refreshment, Mr. Ober and myself rode with our guide Rafael fifteen miles to Amecameca, while our *guias* trotted the whole distance on foot behind their pack mules.

Nothing is more monotonous in its flatness than a Mexican bedstead, while the mattress is only thicker than a Mexican blanket, the bed being but a little more yielding than the soft side of a pine board, but that night—spent in a second-class Mexican hostelry, after such a long day's work with the alpenstock and in the saddle, half frozen in the morning on the mountain side and half roasted in the hot mountain gorges and on the dusty plains in the afternoon,—that night was given without reservation to the worship of Morpheus. The next day at ten we reached the site of ancient Tenochtitlan, rested in the grand plaza under the shade of the orange and banana, by the plashing fountain, our eyes feasting on the varied, ever-changing pictures of Indian, Mestizo and Spanish types of Mexican life passing before us in that famous square.

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NOTES ON THE CECODOMAS, OR LEAF-CUTTING ANTS, OF TRINIDAD.

BY C. BRENT.

AN opportunity was afforded me during the winter of 1884-5 for studying the life and habits of this most interesting species on the Island of Trinidad, West Indies. Several species are here distinguished; all, however, are alike in form and habit, the variety being produced by variation in size and color. These insects are extremely numerous, indeed one cannot take a walk anywhere in the country without observing broad columns of